PART 2

LM3-EUTRO

Chapter 2. Recommendations

LM3-Eutro captured nutrient and phytoplankton trends in Lake Michigan and fit the project field data relatively well. This built confidence in how well the model will be able to describe the system and predict total phosphorus, phytoplankton, and particulate organic carbon (POC) concentrations under different loading scenarios. However, LM3-Eutro has a number of limitations and there are several improvements that can be made to improve the accuracy and predictive capability of the model.

- Presently the framework does not include a sediment sub-model and instead uses user-defined fluxes. A sediment model is recommended to describe nutrient interactions between the sediment and water column. A sediment submodel, coupled with the present water column model, would provide an integrated framework that conserves mass in both the water and sediments.

- The initial conditions were estimated on the Level 2 segmentation scheme. Because the model is sensitive to the initial conditions, especially over the first few years of predictions, it would be preferable to calculate initial condition on the high-resolution Level 3 segmentation scheme.

- Few laboratory and field measurements were performed to estimate kinetic coefficients. Limited laboratory production experiments were conducted for use in the model. Measurements estimating Lake Michigan specific coefficients, especially the phytoplankton growth coefficients, would improve the reliability of the model.

- Additional field and laboratory data would have benefitted the construction, calibration, and confirmation of the LM3-Eutro model.

- Although the lake was sampled eight times during the 1994-1995 period as part of the Lake Michigan Mass Balance Project (LMMBP), additional field measurements would have allowed this high-resolution model to be better constrained.

- Additional sampling during the spring phytoplankton bloom period would improve our understanding of Lake Michigan phytoplankton dynamics and thus assist in construction and calibration of the model.

- Laboratory chlorophyll *a* measurements, in addition to Seabird fluorescence estimates, should be used for future phytoplankton estimates.

- No zooplankton concentration estimates below the thermocline were available for this study. Hypolimnetic or whole water column zooplankton tows would improve the accuracy of the model.

- Limited soluble reactive phosphorus (SRP) data were collected for this study and most of the results were below the detection limit of 1 µg/L. A more complete SRP data set, using an analytical method with a lower detection limit, would be helpful.

- Access to an independent data set(s) to confirm the model would improve the credibility of the model.

- Relatively few samples were taken in Green Bay during this project. Examination of the Green Bay Mass Balance Project (GBMBP) data set suggests that these data are already "out-of-date" due to improvements in conditions in the bay. A more complete recent data set for Green Bay would improve the model's ability to describe the bay and, to a lesser extent, benefit the overall mathematical framework.

- The hydrodynamics for the project year were incomplete. A constant overall lake temperature was assumed for the first three months of 1994 in the Princeton Ocean Model (POM) hydrodynamics calculation. No hydrodynamics exist beyond December 21, 1995. A complete two-year hydrodynamics data set would be useful during model calibration and forecast scenario simulations.

- Limited sensitivity analyses (not included in this document) have been performed to date. No uncertainty analyses have been performed. Sensitivity and uncertainty analyses will identify the effect of the many processes and coefficients on the model and indicate how accurate the model predictions are. However, both of these procedures are a major undertaking in a high-resolution model like LM3-Eutro due to the large number of segments and time required to complete a single simulation. Commonly used methods such as Monte Carlo analysis are almost impossible to perform due to the time and disk space requirements for a single simulation (and hundreds, if not thousands, of simulations will probably be necessary). In addition, these methods provide only an estimate of parameter uncertainty and do not address issues such as structure or scenario uncertainty.

- A longer record of hydrodynamics data for Lake Michigan (e.g. 1983-1995) would be useful in running forecast scenarios. This would allow determination of "typical" hydrodynamics data for use in longer model simulations.

- Updated phosphorus loading data (and to a lesser extent nitrogen and silica) would allow for a more accurate estimation of future loading trends used in longer model scenarios.